Name Key

AP Physics

Period ________

Date ________

AP Review # 8

Mrs. Nadworny

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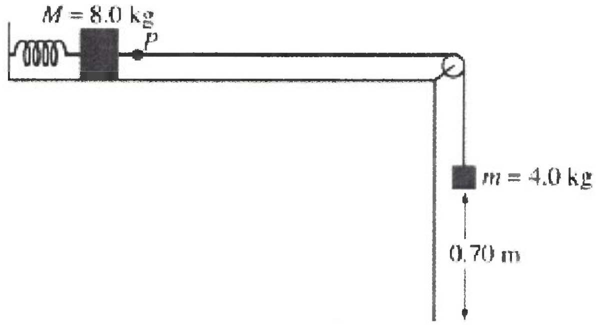


1. (15 points)

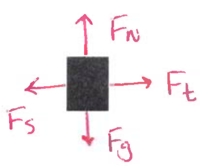
An ideal spring of unstretched length 0.20 m (l_0) is placed horizontally on a frictionless table as shown above. One end of the spring is fixed and the other end is attached to a block of mass $M = 8.0$ kg. The 8.0 kg block is also attached to a massless string that passes over a small frictionless pulley. A block of mass $m = 4.0$ kg hangs from the other end of the string. When this spring-and-blocks system is in equilibrium, the length of the spring is 0.25 m (l_2) and the 4.0 kg block is 0.70 m (h) above the floor.

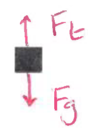
(a) On the figures below, draw free-body diagrams showing and labeling the forces on each block when the system is in equilibrium.

M = 8.0 kg m = 4.0 kg

(1) both vertical

(1) both horizontal





(1) both correct w/ label

(b) Calculate the tension in the string.

(c) Calculate the force constant of the spring.

The string is now cut at point P.

(d) Calculate the time taken by the 4.0 kg block to hit the floor.

(e) Calculate the frequency of oscillation of the 8.0 kg block.

(f) Calculate the maximum speed attained by the 8.0 kg block.

b) block m

$\Sigma F = 0N$

$F_t - F_g = 0N$ (1) eqn

$F_t = mg$

$= (4.0kg)(9.81 m/s^2)$

$= 39N$ (1)

c) block M

$\Sigma F = 0N$

$F_t - F_s = 0N$ (1) eqn

$F_t = F_s$

$F_t = kx$

$k = \frac{F}{x} = \frac{39N}{.05m}$ (1) correct x

$= 780 N/m$ (1) correct answer, +

d) $t = \sqrt{\frac{2d}{a}}$ (1) approach

$= \sqrt{\frac{2(.70m)}{9.81 m/s^2}}$

$= .38s$ (1) answer

e) $T = 2\pi\sqrt{\frac{m}{k}}$ (1) approach for ω

$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

$= \frac{1}{2\pi}\sqrt{\frac{780 N/m}{8.0kg}}$

$= 1.6 Hz$ (1) answer

($\omega = 10 rad/s$)

f) $v_{max} = A\omega = A(2\pi f)$ (1) conserve E

$= (.05m)(2\pi)(1.6Hz)$

$= .49 m/s$ (1) correct sub + answer

(1) correct units on all answers

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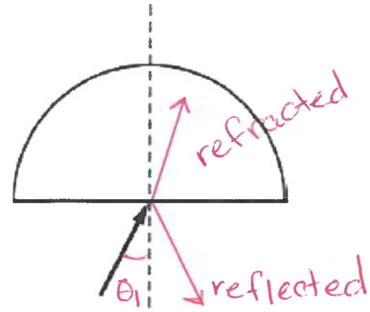

4. (15 points)

A ray of red light in air (λ = 650 nm) is incident on a semicircular block of clear plastic (n = 1.51 for this light), as shown above. The ray strikes the block at its center of curvature at an angle of incidence of 27°.

(a) Part of the incident ray is reflected and part is refracted at the first interface.

i. Determine the angle of reflection at the first interface. Draw and label the reflected ray on the diagram above.

$\theta_i = \theta_r = 27°$

ii. Determine the angle of refraction at the first interface. Draw and label the refracted ray on the diagram above.

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1.00 \sin 27° = 1.51 \sin\theta_2$ (1) sub into eqn

$\theta_2 = 17.5°$ (1) answer

iii. Determine the speed of the light in the plastic block.

$V = \frac{c}{n} = \frac{3 \times 10^8 \text{ m/s}}{1.51} = 1.99 \times 10^8 \text{ m/s}$ (1) answer

iv. Determine the wavelength of the light in the plastic block.

$\lambda_{plastic} = \frac{\lambda_{air}}{n} = \frac{650 \text{ nm}}{1.51} = 430 \text{ nm}$

(1) eqn (1) answer w/units

(b) The source of red light is replaced with one that produces blue light (λ = 450 nm), for which the plastic has a greater index of refraction than for the red light. Qualitatively describe what happens to the reflected and refracted rays.

(1) • The reflected ray does not change because $\theta_i = \theta_r$ does not depend on the index of refraction.

(1) • The refracted ray would bend closer to the normal line, decreasing θ_2

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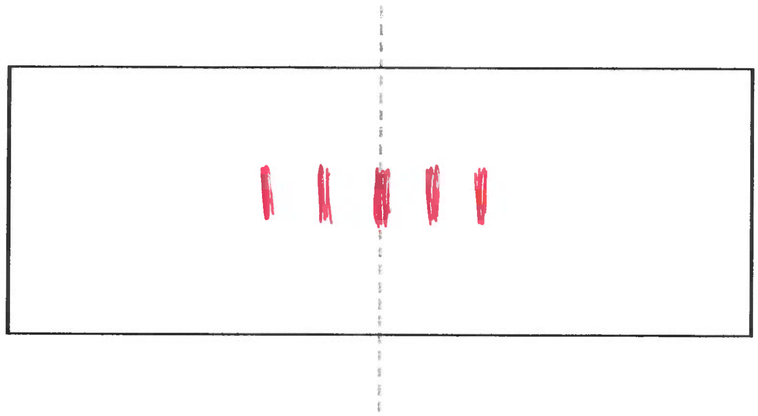
(c) The semicircular block is removed and the blue light is directed perpendicularly through a double slit and onto a screen. The distance between the slits is 0.15 mm. The slits are 1.4 m from the screen.

d L

i. On the diagram of the screen below, sketch the pattern of light that you should expect to see.



Midpoint
between slits

(1) central peak
(1) even spacing

ii. Calculate the distance between two adjacent bright fringes.

$$x = \frac{m\lambda L}{d} = \frac{(1)(450 \times 10^{-9}\,m)(1.4\,m)}{.15 \times 10^{-3}\,m} = .0042\ m$$

(1) eqn

(1) answer
+units

OR

① $m\lambda = d\sin\theta$

$\theta = .172°$

② $x = L\tan\theta$

$= .0042\,m$